

Active Hydrogen Maser

GNS Ground Control

Calibration Deep Space Navigation

GPS Performance Monitoring

Space Qualified

Precise Time

Galileo Onboard Clock

and Frequency

Standards

VLBI

GNS Ground Control
GPS
Space Qualified

Measurement &

Distribution

GNS Ground Control

Deep Space Navigation

Defence Rb

GPS Performance Monitoring

Metrology

Glonass Ground Control

VLBI

Common View Time Transfer

VLBI

Galileo Onboard Clock

GPS

Space Qualified Passive Hydrogen Maser

Space Qualified Rubidium Aerospace Qualified

GPS Performance Monitoring

Common View Time Transfer

Metrology

Calibration

VLBI

Galileo Onboard Clock

Aerospace Qualified Rubidium Frequency Standards

Rb GNS Ground Control

Defence Rb NATO Stock #

Common View Time Transfer

VLBI

GPS Performance Monitoring

Defence Rb NATO Stock # Space Qualified

Galileo Onboard Clock

GPS Metrology

Calibration

Deep Space Navigation

Galileo Onboard Clock GNS Ground Co

Control Space Qualified Passive Hydrogen

Galileo

Defence Rb NATO Stock #

Common View Time Transfer

Deep Space Navigation

Metrology

Calibration

Common View Time Transfer

Galileo Onboard Clock

VLBI

GPS Performance Monitoring



AEROSPACE PRODUCTS AND PROJECTS

Space Qualified Rubidium - *research complete*

Space Qualified Passive Hydrogen Maser
size & weight reduction study complete

Active Hydrogen Maser for Deep Space Navigation
complete

Space Qualified Active Rubidium - *research complete*

E-17 Δf Measurement System - *complete*

Very Low Phase Noise Measurement - *system complete*

High Phase Stable Distribution Amplifiers - *complete*

COMPLETED PROJECTS GNS GROUND CONTROL

All Glonass ground control stations employ CH1-75
Active Hydrogen Masers

Royal Aerospace Establishment DRA
GPS monitoring reference employs CH1-76
Passive Hydrogen Maser

Baikonur (Kazakstan) Launch Facility CH1-75

Plisezk (Russia) Launch Facility CH1-75 Active Hydrogen Maser

COMPLETED VLBI PROJECTS

DLR Germany

Yebes Spain

Upsala Sweden

Japan

10 Installations Russia

Peoples Republic of China

Geodetic Survey Canada

SATCOM FREQUENCY REFERENCE

Royal Air Force UK

UK SPACE CLOCK ALLIANCE

Astrium UK
Kvarz UK & CIS
Quartzlock UK
Quantum Physics Research UK
(a EC 'craft' RTD provider)

Over 400 hydrogen masers in use worldwide - from Kvarz and Quartzlock



New EC service and production facility for Masers with Metrology laboratory
at Sittingbourne Research Centre, Kent, UK.

CUSTOMER REFERENCES

British Aerospace

Marconi

Thales

Alcatel

Lucent

Motorola

Ericsson

Nokia

Nortel

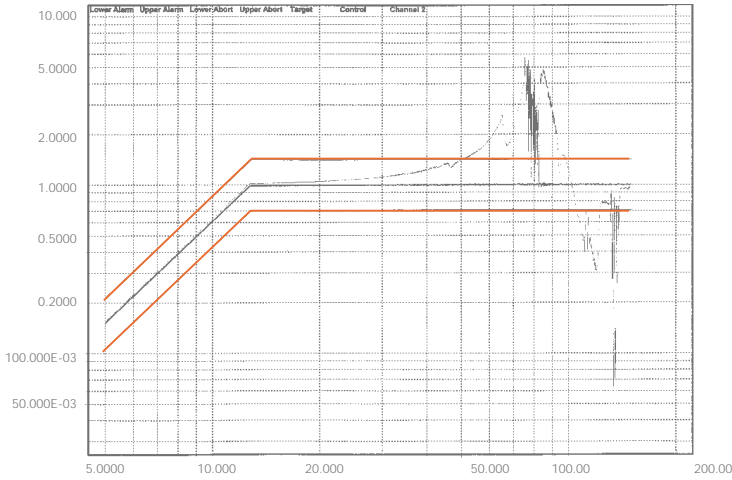
DLR

ATOMIC FREQUENCY STANDARD COMPARISON TABLE

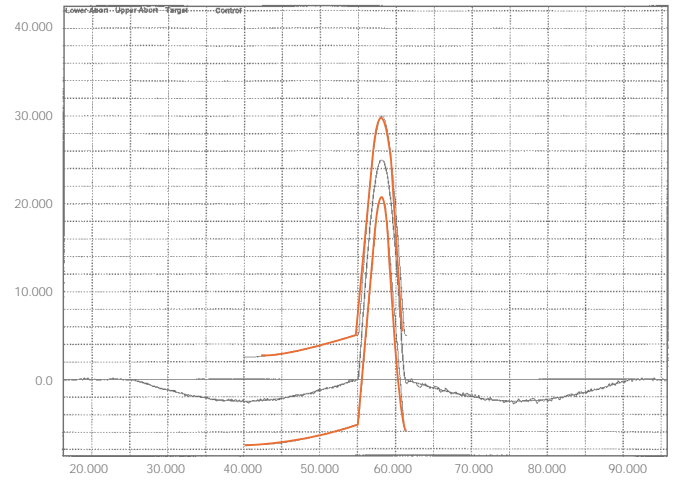
Specifications	Deep Space Navigation Active Maser CH1-75 (Low Noise)	Active Hydrogen Maser CH1-75	Active Hydrogen Maser CH1-75A (Autonomous Auto Tune option)	Active Hydrogen Maser CH1-75 (2 units) = CH1-75B	Passive Hydrogen Maser CH1-76	S-PHM Space Qualified Passive Hydrogen Maser A1	S-RAFS Space Qualified Rubidium Atomic Frequency Standards	HSRO High Stability Rubidium Oscillator A10	S-ARFS Active Rubidium Atomic Frequency Standard
Sine wave									
Frequency MHz	5,70,100	5,100	5,100	5,100	5	10	10	10	5
Voltage at 50 Ohm load, V	1± 0.2	1±0.2	1±0.2	1±0.2	1±0.2	7dBm±1			1± 0.2
Harmonic distortion, dB	-30	-30	-30	-30	-30	-60	-40	-40	-40
Non-harmonic distortion in 10 Hz - 10kHz range dBc	-120	-120	-120	-120	-100	-84 & -60	-84 & -60	-80	-100
Phase noise dBc/Hz		BVA							
1 Hz	-130	-110 -130	-110	-110	-100	-124	-90		
10 Hz	-145	-130 -145	-130	-130	-120	-146	-110		
100 Hz	-153	-140 -153	-140	-140	-140	-155	-130	-135	
1000 Hz	-156	-150 -156	-150	-150	-150	-155	-150	-145	-170
10000 Hz	-156	-150	-150	-150	-150	-155		-155	-170
Frequency, Hz		1	1	1	1				
Amplitude at 50 Ohm load, V		>2.5	>2.5	>2.5	>2.5				
Width, ns		10 - 20	10-20	10-20	10-20				
Rise time, ns		15	15	15	30				
Jitter ns		0.1	0.1	0.1	0.1				
Frequency accuracy (within 1 year period)	3x10 ⁻¹²	±3·10 ⁻¹²	±1·10 ⁻¹²	±5·10 ⁻¹³	±1.5·10 ⁻¹² (Over 3 years)		1.0·10 ⁻¹⁰		
Frequency stability (Allan deviation)									
1s	1x10 ⁻¹³	2·10 ⁻¹³	3·10 ⁻¹³	2·10 ⁻¹³	1.5·10 ⁻¹²	1·10 ⁻¹²	5·10 ⁻¹²	3·10 ⁻¹²	8x10 ⁻¹⁴
10s	3x10 ⁻¹⁴	3·10 ⁻¹⁴	5·10 ⁻¹⁴	3·10 ⁻¹⁴	5·10 ⁻¹³	3.2·10 ⁻¹³	1.5·10 ⁻¹²	1·10 ⁻¹²	4x10 ⁻¹⁴
100s	5x10 ⁻¹⁵	5·10 ⁻¹⁵	1·10 ⁻¹⁴	1·10 ⁻¹⁴	1.5·10 ⁻¹³	1·10 ⁻¹³	5·10 ⁻¹³	4·10 ⁻¹³	1x10 ⁻¹³
1000s	2.5x10 ⁻¹⁵	2.5·10 ⁻¹⁵	5·10 ⁻¹⁵	5·10 ⁻¹⁵	5·10 ⁻¹⁴	3.2·10 ⁻¹⁴	1.5·10 ⁻¹³		3x10 ⁻¹³
1h	1x10 ⁻¹⁵	1·10 ⁻¹⁵	3·10 ⁻¹⁵	3·10 ⁻¹⁵	2·10 ⁻¹⁴	1·10 ⁻¹⁴	7·10 ⁻¹⁴		5x10 ⁻¹²
1 day	1x10 ⁻¹⁵	1·10 ⁻¹⁵	5·10 ⁻¹⁵	2·10 ⁻¹⁵	1·10 ⁻¹⁴		5·10 ⁻¹⁴		
Frequency drift per 1 day									
At delivery	5x10 ⁻¹⁵	5·10 ⁻¹⁵	5·10 ⁻¹⁶	5·10 ⁻¹⁶	2·10 ⁻¹⁵				
After 1 year operation	3x10 ⁻¹⁵	3·10 ⁻¹⁵	3·10 ⁻¹⁶	3·10 ⁻¹⁶	1·10 ⁻¹⁵	3·10 ⁻¹²	3.0·10 ⁻¹¹		
Temperature frequency coefficient / °C	2x10 ⁻¹⁵	2·10 ⁻¹⁵	2·10 ⁻¹⁵	5·10 ⁻¹⁶	2·10 ⁻¹⁴		1·10 ⁻¹³		
External magnetic field effects / Gauss	1x10 ⁻¹⁴	1·10 ⁻¹⁴	1·10 ⁻¹⁴	1·10 ⁻¹⁴	2.5·10 ⁻¹⁴	2·10 ⁻¹⁴	1·10 ⁻¹³		
Frequency corrector resolution	1x10 ⁻¹⁵	1·10 ⁻¹⁴	1·10 ⁻¹⁴	1·10 ⁻¹⁴	1·10 ⁻¹⁴				

Rubidium Atomic Frequency Standard A10

Acceleration Pane

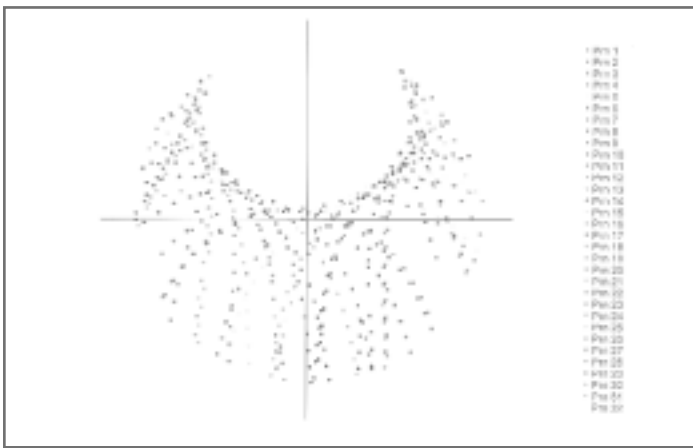


Acceleration Pane

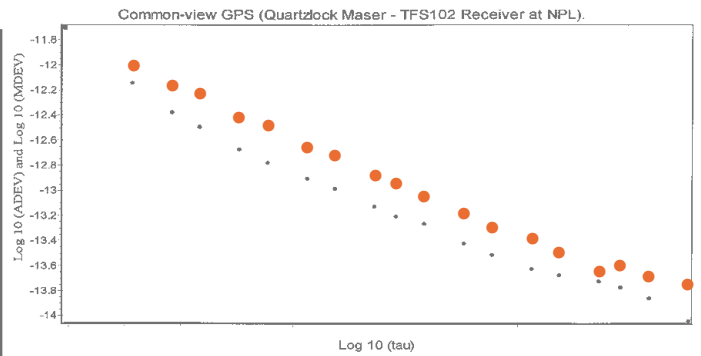


Quartzlock GPS Common View Time Transfer Results A9

Quartzlock Maser-UTC(NPL)
Common-view - sky map view from Totnes

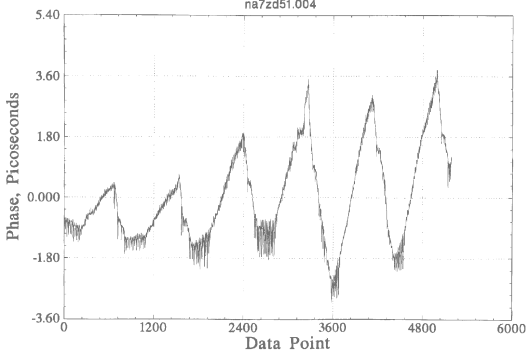


Plots of ADEV and MDEV

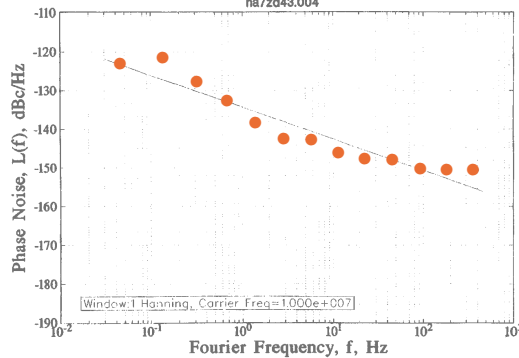


New Frequency, Phase & Phase Noise Measurement System A7

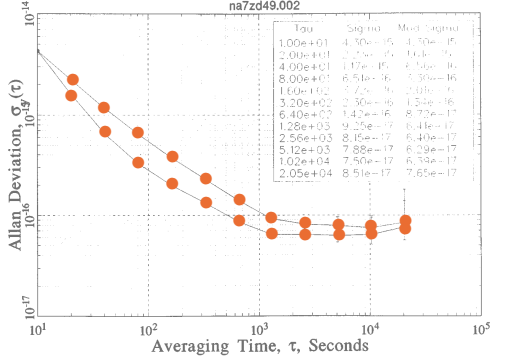
PHASE DATA
na7zd51.004



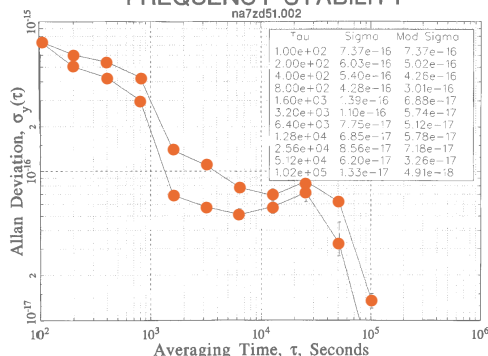
NA7 phase noise
na7zd49.004



NA7 noise floor
na7zd49.002



FREQUENCY STABILITY
na7zd51.002



Quartzlock
The most stable Frequency Standards available
GPS - Maser & L1 Trunk M
Femtosecond Atomic Reference
Hydrogen Maser

ISO 9001

Craft Award 2000/2

NIST Traceable Standard

NPL Referenced

5x dti Smart Awards

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